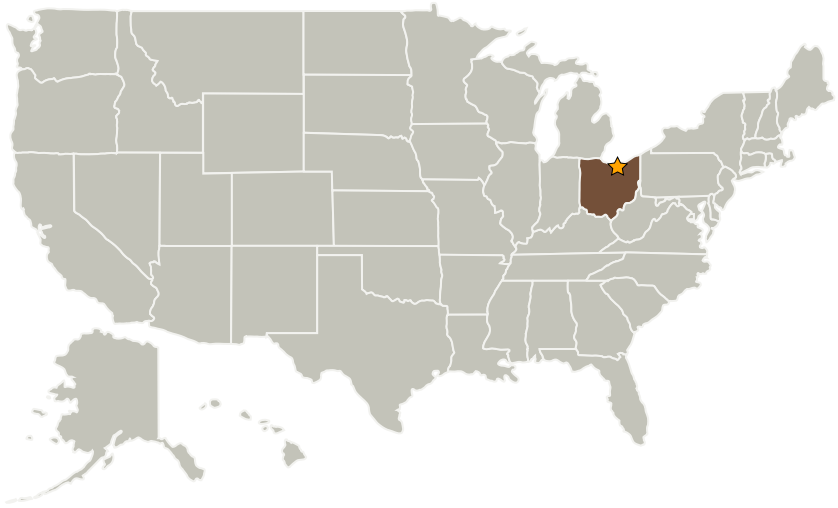
# Physics-Based Probabilistic Design Tool with System-Level Reliability Constraint, Phase II

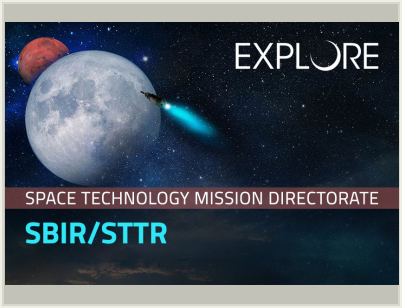
Completed Technology Project (2005 - 2007)

## Project Introduction

The work proposed herein would develop a set of analytic methodologies and a computer tool suite enabling aerospace hardware designers to rapidly determine optimum risk-constrained designs subject to multiple physics-based uncertainties in applied loads, material properties, and manufacturing processes. This means that the design process no longer would consist of a sequence of separate code invocations to: (1) obtain the geometry model, (2) determine the various loads, (3) determine performance, (4) perform a structural analysis, (5) perform design optimization, and (6) perform a probabilistic risk assessment. Instead, all of these functions would be automatically incorporated into a single framework using existing physics-based deterministic modeling codes and a set of computer-generated data transfer interfaces. Thus, a design engineer would be able to rapidly explore the design space to identify the minimum weight design that meets a given reliability constraint ? thereby avoiding both an overly conservative design and an excessively risky design. Moreover, the methodology would also rollup component-level uncertainties to the system level for multiple components -- thereby enabling a system level reliability constraint to be imposed at the component level. Advanced techniques will be developed including methods to: (a) determine confidence bounds on reliability predictions, (b) efficiently determine response surfaces, and (c) use physics-based progressive failure modeling. The software tool could be used, for example, to determine the wall thickness of a launch vehicle's external cryogenic propellant tanks exposed to high but uncertain thermal and aerodynamic loads with a reliability of 0.99999.

## Primary U.S. Work Locations and Key Partners



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## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Glenn Research Center (GRC)

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

**Small Business Innovation Research/Small Business Tech Transfer**

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| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| ★Glenn Research Center(GRC) | Lead Organization | NASA Center | Cleveland, Ohio |
| N&R Engineering | Supporting Organization | Industry<br>Small Disadvantaged Business (SDB) | Parma Heights, Ohio |

| Primary U.S. Work Locations |
|---|
| Ohio |

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

## Technology Areas

**Primary:**

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.2 Structures
    - TX12.2.3 Reliability and Sustainment